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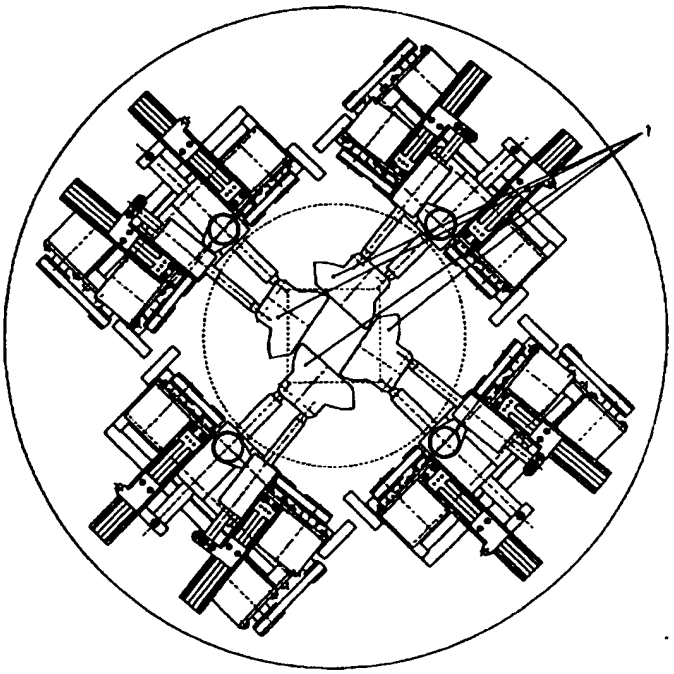
(54) Title: METHOD FOR AUTOMATIC FINAL COLLIMATION OF IONIZING RADIATION

(57) Abstract

This invention is a device for collimation of ionizing radiation when treating tumors and similar in the human body. The purpose of the invention is to achieve the function of a device replacing the manual procedure of today in many treatment cases. The aim is also to achieve a device which is a less expensive alternative to the multileaf collimators used today. The most important function of the device is that 4 collimator blocks are used as final collimator. Each of these blocks is used to individually "cut off" a corner in the square radiation area shaped by the pre-collimator. The "cutting off" can be applied for various sizes of the squares as well as various angles.



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Method for automatic final collimation of ionizing radiation

The technique's standpoint:

In radiation treatment of tumours in the human body using ionizing radiation produced in a linear accelerator, see figure 1, today 4 "stationary blocks" (pre-collimators) are used to screen off the beam to be square shaped. The size of the square depends on the target's outer contour, see figure 2.

To shape the beam more exact to the target (final collimating) today a number of methods are used. For example separate final collimators are moulded with a unique shape for each target. This is the most exact method but also the most time consuming. Another method is to place separate pieces of some material with high density in the beam field to shield off the beam to the shape of the target. At each treatment also the number of beam directions varies, mostly 6-8, which means that the final collimator's shape must be modified between each direction. All this is manual work and very time consuming.

When the collimation is not manual mostly multileaf-collimators are used, but these are often too complicated, large, heavy and too expensive for some applications. Multileaf-collimators' function can be compared to a profile template.

All the different types of final collimators are attached in a holder under the "stationary" collimator-blocks, see figure 1 (1). The manual collimators are detachable, and the multileaf collimator is fixed to the gantry. The stationary collimator blocks according to figure 2 are placed normally at pos. 15 in figure 1.

Estimations have been done which prove that you can gain conformity of the radiation to the target by "cutting off" the corners in the square shaped by the four above mentioned stationary collimator blocks, see figure 3.

The rather exact shape after the target, allowed by the multileaf collimators, which results in a very small size of radiated healthy can also be achieved by using the invention described below. When treating certain circular targets the multileaf-collimators give an inferior result than the described invention would give, see comparing geometry in the upper left corner in figure 3. (The multileaf profile has step form in the figure). A "cutting off" corners collimation is often used in the earlier described manual collimation with separate blocks. There is a request to automatize this procedure.

The purpose of the invention and its most important features

The purpose is to achieve a method that in many treatment cases could replace the above described manual procedure. The purpose is to achieve a less expensive method than the multileaf collimators used today, with the same conformity of the radiation field. The most important feature of this method is that 4 collimator blocks are used as final collimator. Each of these blocks is used to "cut off" a corner of the square shaped radiation area made by the pre-collimator, see figure 3. The cutting off can be made for various sizes of the squares and in various angles.

Description of the figures

Figure	Describes:
1	the principle for radiation when using linear accelerator
2	the principle of the pre-collimator
3	the principle for "cutting off" corners with one example of a multileaf shape cut off
4	the collimators (1) and driving mechanism (bottom view)

5 detailed drawing of one collimator and its driving mechanism

6 the collimator mounted in its house (side view)

7 drawing of the principle of the intervention of the beam by 2 collimators (side view)

Description of the invention

The arrangement consists of 4 identical units, see figure 4. There is one unit in each corner, in figure 5 only one unit is shown. The four movable corner blocks (1), made of high density material, like tungsten, are situated between two spherical surfaces (2) resulting in always keeping the edges of the blocks parallel (3) to the beam (4). The corner blocks' (1) geometry is such that all sides of the corner blocks (1) always are in the normal direction from the spherical surfaces (2) which they are controlled by. Three linear movements make the positioning of the blocks. One movement (5) is parallel with the moving area itself. The second linear movement works perpendicular to the first one (6). The third linear movement (7), which is linked in both ends (8), is used to get the correct angle of the blocks. The whole mechanism is linked in (14) to allow relative movements towards corner blocks (1) and spherical surfaces (2).

The control of the movements is taken care of by a computer receiving the requested shape of the beam. The signals are sent to a step motor (9), one for each movement, which by some type of transmission (10) runs a screw (11) which makes the linear movement.

To make sure that the setting is the decided one, a linear sensor (12) is installed, which checks the position and compare it with the position which has been reached by the motor.

Claims

1. Device to limit radiation, especially the high energetic, consisting of a pre-collimator for shaping square radiation areas and a final collimator characterized by its collimation blocks are individually adjustable in two dimensions.

2. Device according to claim 1 characterized by that the adjustment consists of a transversal movement in two directions and one rotation.

3. Device according to claims 1 or 2 characterized by that the collimator blocks move in a spherical way and as a result the sides' gradient is adapted to the radiation's divergence.

4. Device according to claims 1-3 characterized by that the collimator blocks will be adjusted by motors.

5. Device according to claims 1-4 characterized by that the collimator block's position is controlled partly by a control motor, partly by a separate control method.

6. Device according to claims 1-5 characterized by that the collimator blocks material has high density, preferably lead and tungsten.

7. Device according to claims 1-6 characterized by that the number of collimator blocks is at least four.

8. Device according to claims 1-7 characterized by that the whole collimator package can be rotated around the central line of the beam.

Summary

This invention is a device for collimation of ionizing radiation when treating tumours and similar in the human body.

The purpose of the invention is to achieve the function of a device replacing the manual procedure of today in many treatment cases.

The aim is also to achieve a device which is a less expensive alternative to the multileaf collimators used today.

The most important function of the device is that 4 collimator blocks are used as final collimator. Each of these blocks is used to individually ''cut off'' a corner in the square radiation area shaped by the pre-collimator, see figure 3. The ''cutting off'' can be applied for various sizes of the squares as well as various angles.

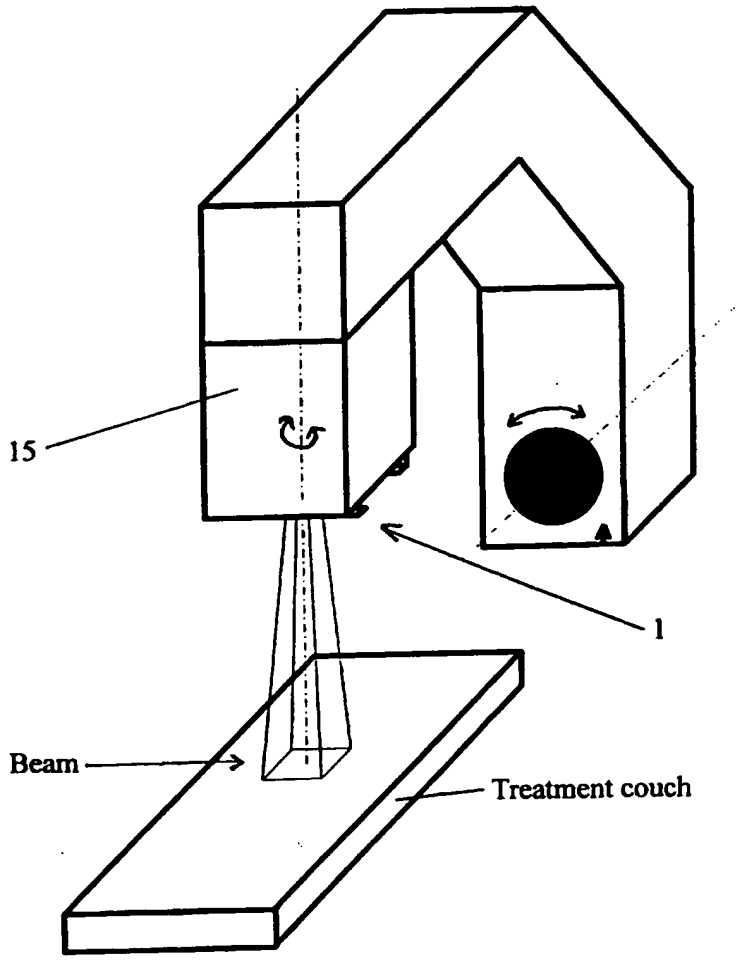


Figure 1:

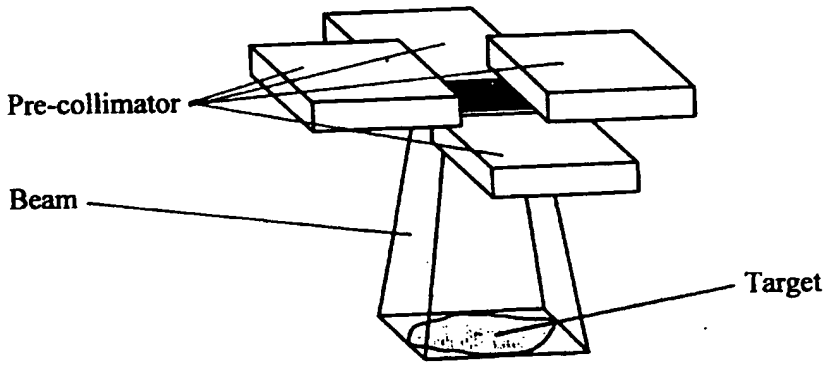


Figure 2:

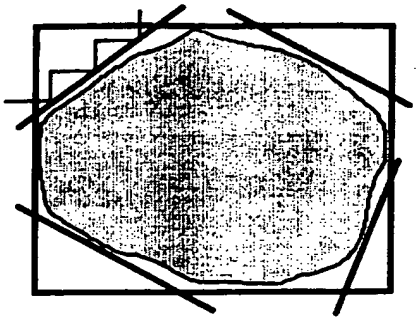
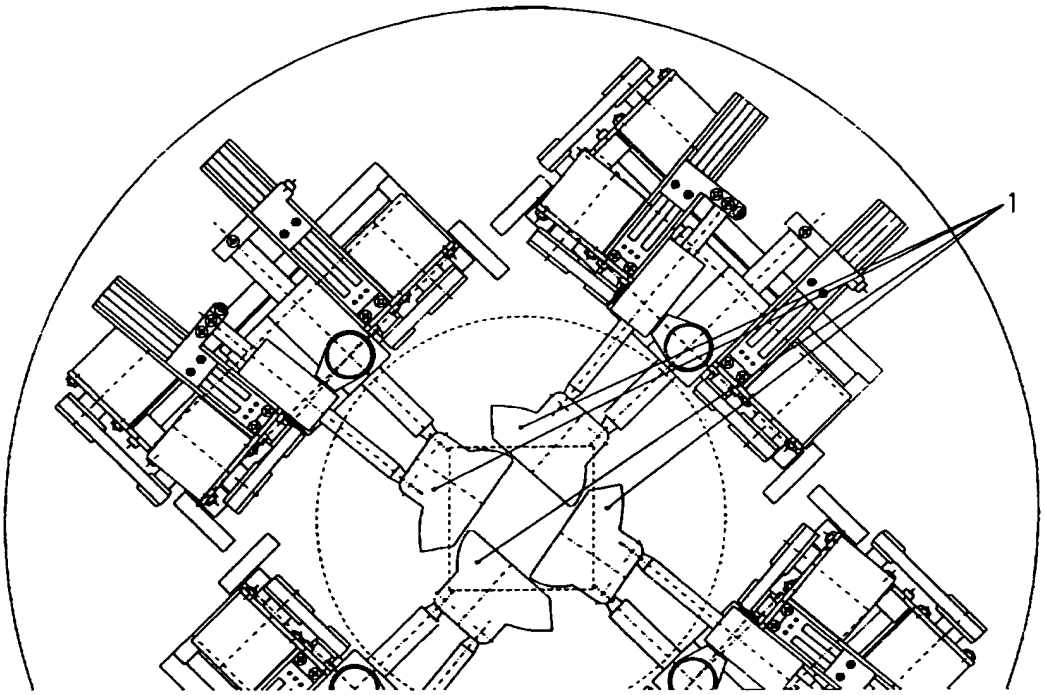


Figure 3:



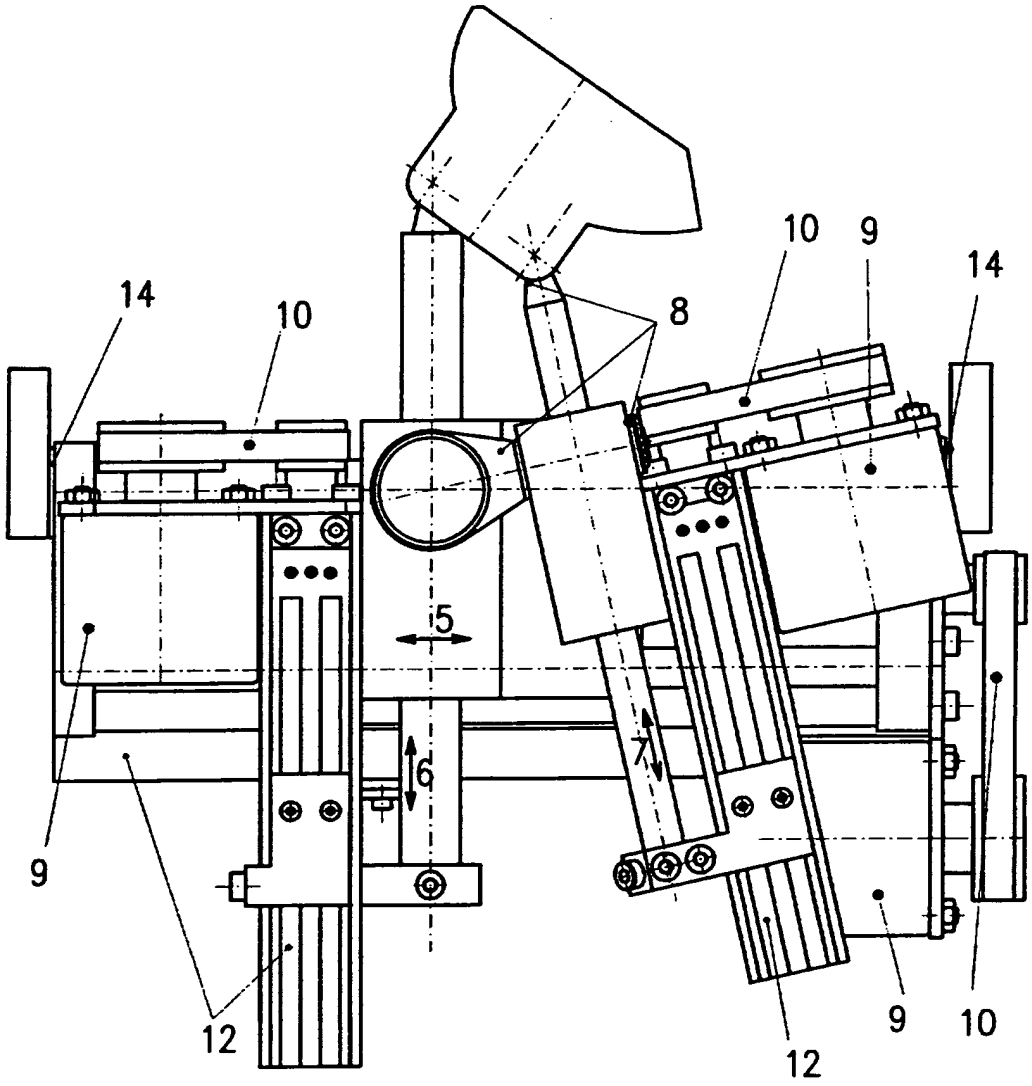


Figure 5:

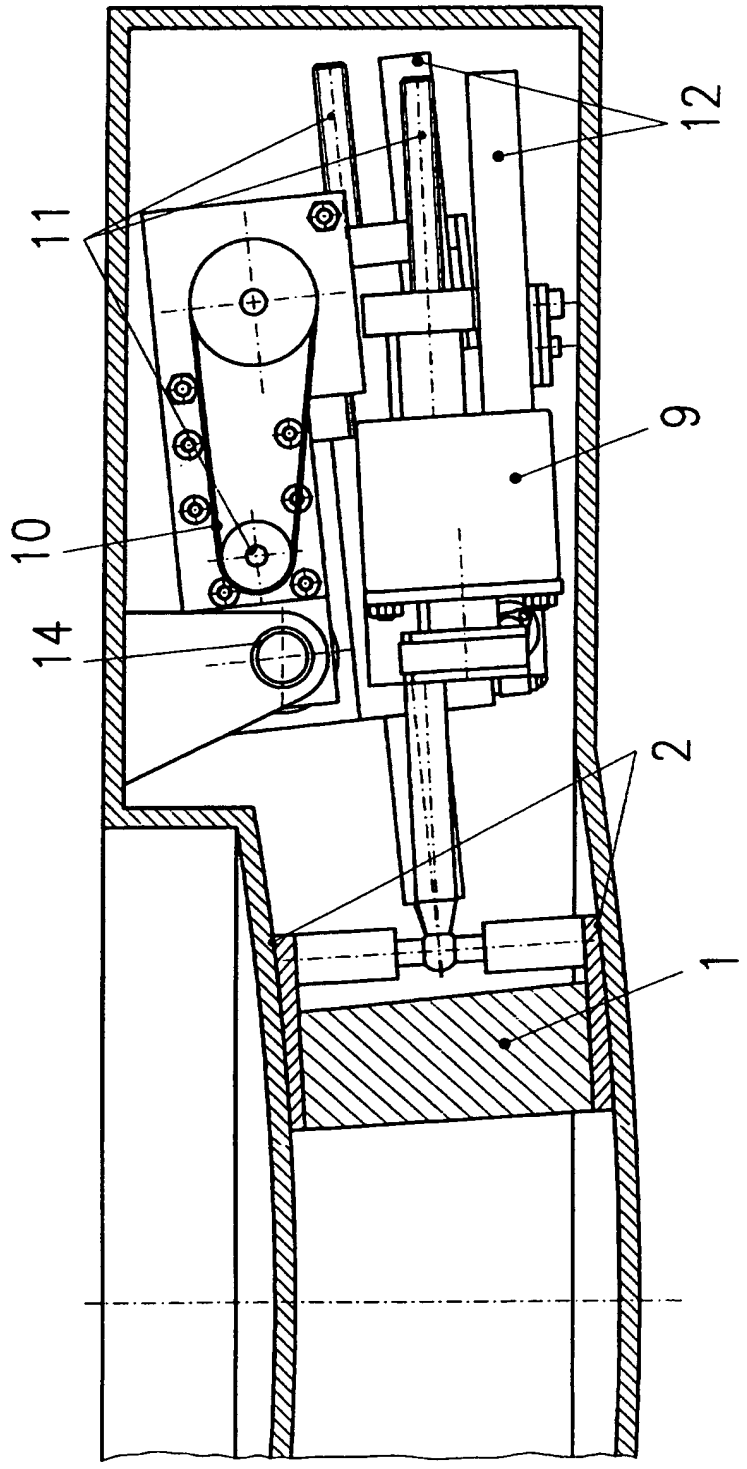


Figure 6:

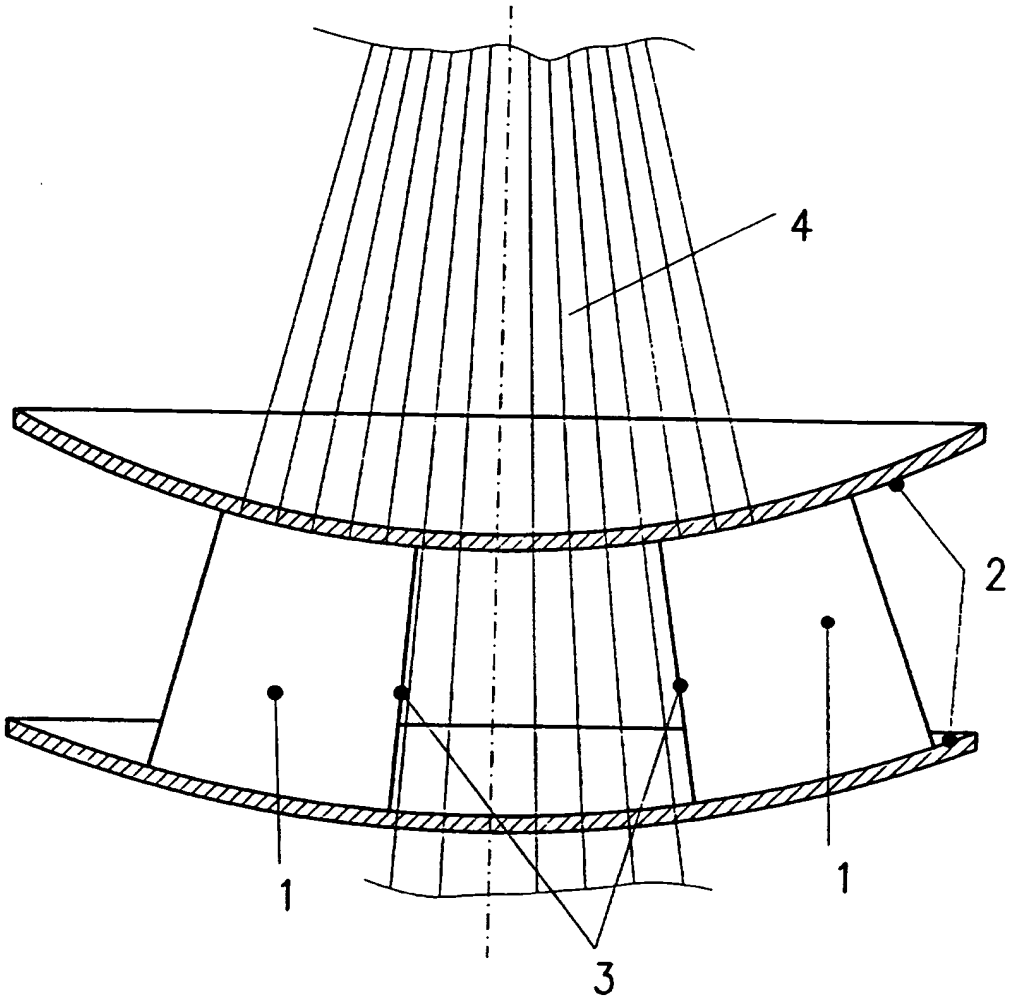


Figure 7:

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/01523

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61N 5/10, G21K 1/04 // A 61 B 6/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61B, A61N, G21K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4514859 A (G. HOLZERMER), 30 April 1985 (30.04.85), figure 2, claim 1	1,2,4,5,7
Y	--	6,8
Y	US 5216255 A (G.A. WEIDLICH), 1 June 1993 (01.06.93), column 3, line 37 - line 46	6,8
	--	
Y	EP 0498438 A1 (KABUSHIKI KAISHA TOSHIBA), 12 August 1992 (12.08.92), column 3, line 49 - line 58	6,8
	--	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Information on patent family members

05/02/96

International application No.
PCT/SE 95/01523

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4514859	30/04/85	DE-A- 3234410	22/03/84
		DE-A- 3376041	21/04/88
		EP-A,A,A 0103794	28/03/84
US-A- 5216255	01/06/93	NONE	
EP-A1- 0498438	12/08/92	JP-A- 4256737	11/09/92
		US-A- 5235627	10/08/93